Teaching Old Dog New Tricks: Improving SrRuO$_3$ for Magneto-Electronic Applications
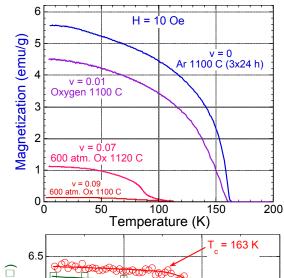
SrRuO$_3$ has been known for half a century as a strongly-correlated ferromagnetic metal with considerable variance of its magnetic properties and T_c ~ 160 K. It is also important for application as an electrode material in micro- and nano-electronic circuits. **We have discovered that the Ru-site vacancies can be created in SrRu$_{1-v}$O$_3$ by processing under oxidizing conditions.** The creation of vacancies dramatically suppresses T_c to 45 K for v ~ 0.09. Synthesis under reducing atmosphere produces stoichiometric material and improves resistive and magnetic properties.
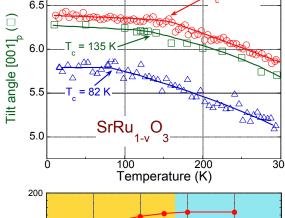
Neutron powder diffraction analysis revealed that below T_c the b and c lattice parameters and the unit cell volume are virtually temperature independent. **We have discovered that this previously reported invar-effect originates from freezing of the octahedral tilting about the c-axis.** Spontaneous magneto-striction has the largest effect on the b axis.
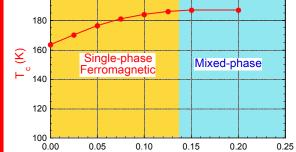
Numerous chemical substitution studies have been performed previously for SrRuO$_3$ resulting in decrease of T_c. **We were able for the first time to increase T_c to 187 K by using "design rules" developed earlier in this project.** We are currently studying the structural and physical properties of these novel materials and considering application for a U.S. patent, as the markedly improved electronic and magnetic properties of these materials may find wide application in the electronic industry.